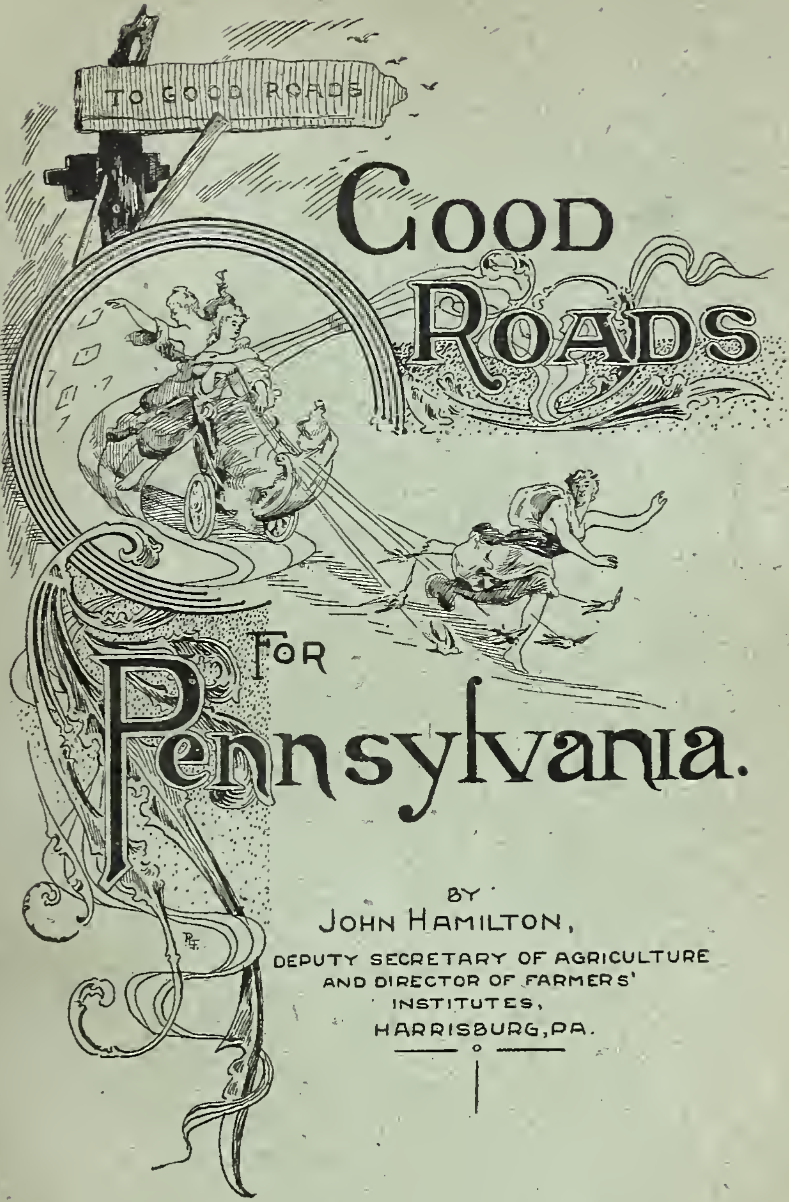

GOOD ROADS FOR Pennsylvania.

BY
JOHN HAMILTON,
DEPUTY SECRETARY OF AGRICULTURE
AND DIRECTOR OF FARMERS'
INSTITUTES,
HARRISBURG, PA.

"I CONSIDER THAT A ROAD SHOULD BE AS FLAT AS POSSIBLE WITH REGARD TO THE WATER FLOWING OFF, BECAUSE A CARRIAGE OUGHT ALWAYS TO STAND UPRIGHT. I HAVE GENERALLY MADE ROADS THREE INCHES HIGHER IN THE CENTRE THAN AT THE SIDES, AND ON THIS SLOPE THE WATER WILL EASILY ESCAPE. WHEN THE ROAD IS MADE FLAT PEOPLE WILL NOT FOLLOW THE MIDDLE OF IT AS THEY DO WHEN EXTREMELY CONVEX. MORE WATER WILL STAND ON A VERY CONVEX ROAD THAN ON A FLAT ROAD, BECAUSE ALL CARRIAGES SEEK AN UPRIGHT POSITION IN THE CENTRE AND THE WEAR THERE WILL, OF COURSE, BE GREATER. THE MOST USEFUL INCLINATION IS IN THE DIRECTION OF A ROAD'S LENGTH, AND ENGINEERS GIVE PREFERNCE TO A MODERATELY INCLINED ROAD OVER ONE RIGIDLY LEVEL. TO SECURE AN EQUAL DISTRIBUTION OF SERVICE, EVERY PART OF A ROAD SHOULD BE EQUALLY HARD AND GOOD TO PREVENT UNEQUAL WEAR."

MACADAM.

BULLETIN No. 15.

THE PENNSYLVANIA DEPARTMENT OF AGRICULTURE.

GOOD ROADS

FOR PENNSYLVANIA,

BY

JOHN HAMILTON,

DEPUTY SECRETARY OF AGRICULTURE AND DIRECTOR OF FARMERS'
INSTITUTES, HARRISBURG, PA.

SEPTEMBER 1, 1896.

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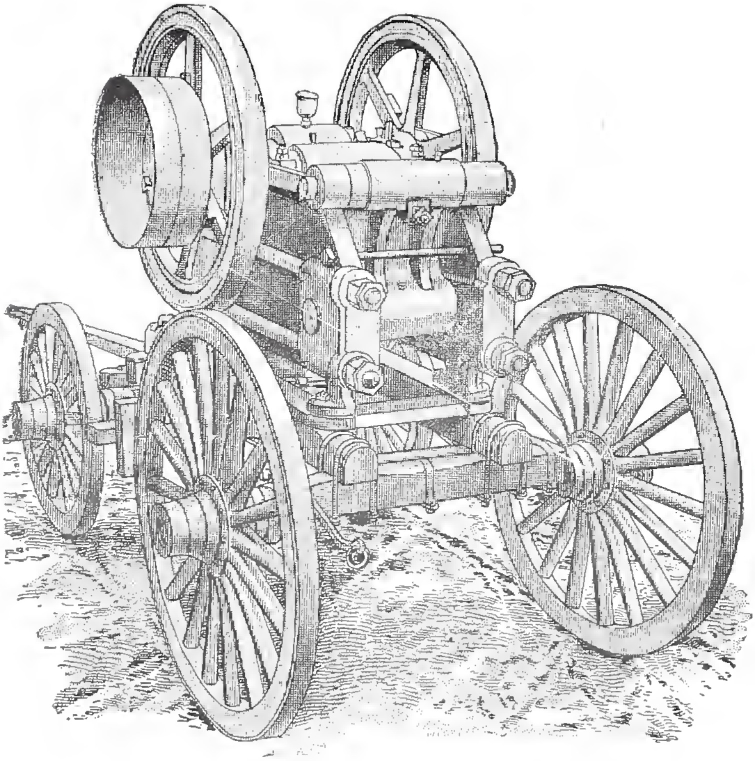


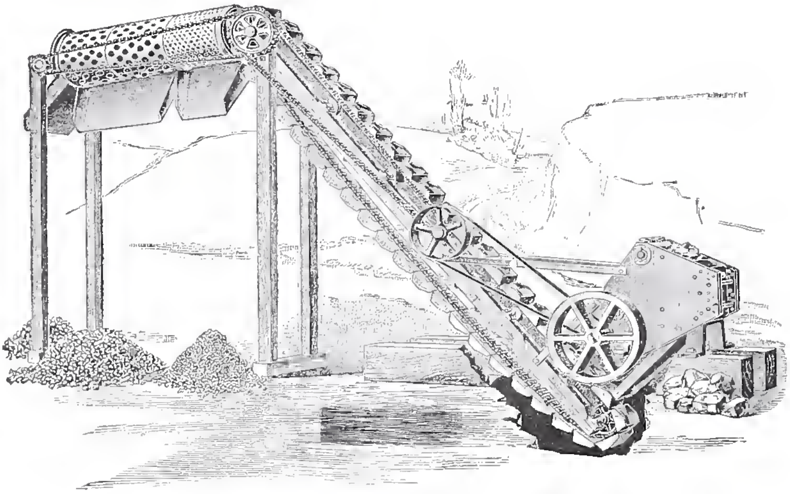
LETTER OF TRANSMITTAL.

DEPARTMENT OF AGRICULTURE,
HARRISBURG, PA., *September 1st, 1896.*

Hon. Thos. J. Edge, Secretary of Agriculture:

Dear Sir: I have the honor to present herewith a paper on the improvement of the public roads of Pennsylvania. It is in no sense an exhaustive discussion of the question, but is intended simply to call the attention of supervisors and others interested in road construction, to some facts and methods, which the writer has found by experience, to be practicable under our present conditions, and which it is believed, will, if carried into operation, speedily bring about a change for the better in the roads of the Commonwealth.

Very respectfully,
JOHN HAMILTON,
Deputy Secretary of Agriculture and Director of Institutes.



PREFACE.

The question of good roads and the best way to secure them, is just now interesting a larger number of people in Pennsylvania, than at any previous time in the history of the Commonwealth, and the State never stood in greater need of good roads than it does today. All of our people concede in a general way their value to the public, and also appreciate the advantages to every locality, of substantial and well constructed means of communication with neighboring towns and villages.

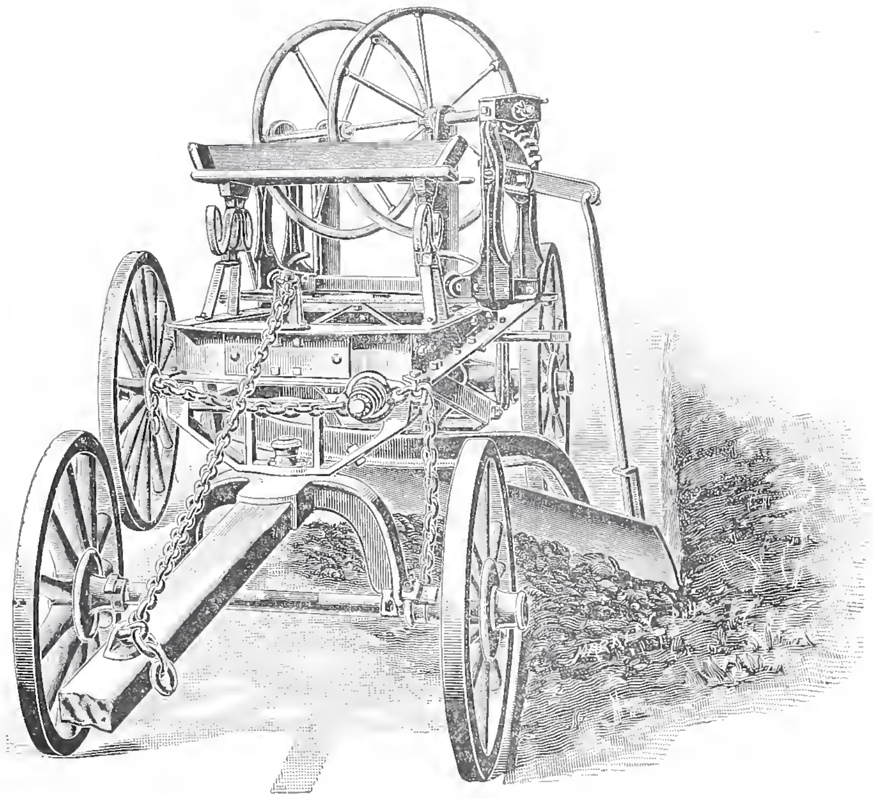
Just now, there is a special necessity for complete and durable highways, that has not before existed. Rapid communication and transportation, whether by steamship, railroad, trolley or country road, are demanded by our civilization, and this demand is not simply for the gratification of the pleasure seeker or the luxurious, but is a necessity in business. Surplus products must be moved greater or less distances to find a market, labor and time have become more costly, and all enterprises that are to succeed in the competition that has set in, have found it imperative to so plan the various operations in their business, that one man, or unit of force, can accomplish twice the work in the same time, and at less expenditure, than was necessary before. The more depressed the industry, the greater is the necessity for cheapening production and reducing expenses.

The business of the farmer is no exception to this rule, and consequently there is no intelligent agriculturist in the Commonwealth, who does not appreciate the importance of better facilities for communication in the country districts; but the difficulty that confronts him and causes him to hesitate, is, to know how this may be accomplished without entailing too great expense, either upon himself directly, or upon the State. The books that have been written, and the estimates of engineers and other experts who ought to know, have for the most part, put the cost of road construction at such considerable, not to say extravagant sums, as to frighten conservative and thoughtful men who have this expense to meet. Indeed, a sad amount of ignorance has been exhibited hitherto, by these same experts, with regard to the best practicable methods of constructing country roads. This is demonstrated nowhere more clearly than in France, whose roads have been under the direct supervision of trained engineers for almost one hundred years, and yet it has only lately been discovered there that the expensive system that heretofore they have used, is much less satisfactory than that which has but recently been introduced, and which involves only about one-third the former cost.

To-day the best engineers have materially modified their estimates of the expense of building roads, until, where circumstances favor, sums quite reasonable are considered adequate, and the question is no longer shut out of consideration by reason of the excessive cost, but is now open for discussion and adoption, by those whose financial condition is such as to make a costly system of highway building a luxury not to be indulged.

The problem now, is not so much *how* to build good roads, for this is fairly well understood; but, situated as we are here in Pennsylvania, are we *able* to build them? Can the farmers who have charge of the highways of the State construct good roads within a reasonable time, and at moderate cost? And will they do it? Some one, we may rest assured, will do it inside of the next twenty years. If the farmers of Pennsylvania conclude that it can be done, and undertake the work. and conduct it in a proper way, they will retain control. If, on the other hand, action is delayed, or they continue to manage this business as it has been in the past, then all of the indications are, that the management will be taken out of their hands and the work will be done by others; and the serious danger is that the farmers, after all, will have to foot the bills.

The writer has realized for many years the importance of this question to the agricultural people of the State, and last winter called the attention of the farmers at the institutes to the necessity for their taking immediate action, in order to prevent some highly expensive system being adopted, which would impose additional burdens upon country people whose load already is too heavy to be borne. It may not be out of place, just here, to state that the author of this bulletin has served for two successive terms as supervisor of roads in the township in which he lives, and therefore speaks, not as a mere theorist, but as one who has carried into practice that which he herein urges upon the people of the Commonwealth at large.



GOOD ROADS.

How much Road does Pennsylvania have?

There are over 80,000 miles of roads in Pennsylvania, outside of the wards and boroughs and cities of the Commonwealth, and not including the turnpike roads under corporate control. For the year ending May 31st, 1895, these 80,000 miles of road cost the farmers of Pennsylvania, just three millions eight hundred and ninety-eight thousand, five hundred and seventy-three dollars and ninety-six cents, or at the rate of forty-eight dollars and seventy-three cents per mile. This expense has been continued for many years, and yet, a comparatively small amount of the roads throughout the State, can be truthfully designated, GOOD. Forty-eight dollars and seventy-three cents for every mile, expended every year; and yet how little that is permanent, to show for this vast expense?

Who are responsible for this enormous waste? As has been intimated, the farmers have complete control of the entire system from end to end. Each township elects its own officials year by year, who are placed in charge of this important piece of public business; these supervisors lay the tax and oversee the work. All responsibility, therefore, for the use or mis-use of this important trust, rests upon the people whom these officials represent. Is it unfair to say, that there must be something radically wrong with a system, that, after trial for over one hundred years, and involving an expenditure of money counted by the hundred millions, has produced only that which we have to-day? Is it not time for us to seriously investigate our practice, and discover, if we can, how to best correct the defects that evidently exist?

The first question we need to ask and answer is:

What is a Good Road?

A good road has several characteristics more or less important, but it has one that is supreme. It is always dry. Dry not only when the weather is clear and fine, but dry also when all else is wet. Dry in mid-summer and dry in mid-winter. Dry always and all over. Some road builders, if judged by their work, would seem to believe that a good road ought always to be wet, for they have permitted them to assume a form best suited to collect and retain the rains that fall, and no matter how dry the earth, or scarce the supply of water may become elsewhere, it can be always found in the numerous mud holes that are located here and there along the center of the public roads. A mud hole in a public road is as much out of place as a pig in a ladies' parlor. It has no business there, and ought to be simply an accident, only to be tolerated until it can be removed.

The building of a dry road is in most places an exceedingly simple matter. Just raise the surface so that the water can run off, make it slightly oval, and provide side ditches to carry off the drainage. This seems too elementary to be necessary to be stated to any thinking man, and yet we have all seen supervisors with a company of sensible citizens stop in their road repairing along side of a section, shut in on each side by steep banks which carry the drainage into the middle of the road, and begin to repair the washed out bed by throwing in some sods and earth from the adjoining bank, covering the stones and inequalities by a slight addition of loose material, which the first shower will wash away, leaving the place worse than it was before.

The next year the operation is repeated by the same supervisor and these same sensible citizens, and so on, from year to year, this worse than useless work is done. Every man in that company knows, very well, that the work will not stand a flood, and yet no one objects or suggests a better way. Such a road, hollowed in the middle, is simply up-side down, and needs to be fixed so that no water can remain in its center, but will drain off to ditches provided at the sides.

A good road is a DRY ROAD, and no wet road ever was, or ever can be good. Get rid of the water, and get it clear off of the right of way. Turn it out into the adjoining fields, and do not let it run long distances in the ditches. Provide for its discharge at every suitable point, and so keep the road clear and prevent the washes that otherwise are sure to follow. Construct these ditches well out at the edges of the right of way, giving all the space possible for public travel. The best method for raising the road bed is by the use of the road machine. Where the rocks are not too numerous, the worst roads can be raised and put in good condition at a cost of from fifteen to thirty dollars per mile. Never leave a piece of road until you are sure that the water will run freely from its surface, for the most important maxim in road construction, is that a good road must be DRY.

The next requisite in a good road is that it is

Solid.

Solid at all seasons of the year. To secure this, stone ballast is the best material within our reach, and this is widely distributed over Pennsylvania. Some of our supervisors knowing that stone ballast is hard, suppose, that being hard, it will necessarily make a solid and durable highway suitable for public use. They accordingly secure teams and engage men, whom they put at work with implements that are only fit for some museum of antiquities, and begin the construction of turnpike road. Stones of every size and quality are hauled upon it, the surface is partially leveled off and the ballast slightly broken over the top, leaving that below practically untouched. Afterwards a light covering of earth is spread over the surface and the road is considered complete, and the work satisfactorily done. Much of the stone road in Pennsylvania is constructed in just this way, and no mistake in road building is greater, or more to be condemned.

That stone ballast is not used in building roads chiefly because it is hard and will stand the wear, but for a wholly different purpose, is evident, when we remember that if a common clay road were taken in mid-summer and completely roofed in by a substantial shed, so that all of the water would be kept off during the entire year, the surface of the road would be hard enough and substantial enough to carry the heaviest loads and stand the wear, yet no stone ballast has been used. What has given to this road its durability and solid bed? The water has been kept off, and these qualities follow as a natural result. The construction of a timber shed cannot, of course, be seriously considered as a practicable method of dealing with our public roads, but we can construct a roof of stone which will answer all the purposes of the shed, and it is for this that stone ballast should be applied.

Take the road which has been constructed with large stones underneath, and only a thin layer broken on the surface, and put it to the test of traffic. The first rain that falls will find its way down through this coarse material and through the spaces between the large unbroken stones, and saturate the clay below. Loaded wagons passing over crush the stones down into the soft clay beneath, a rut is formed, the next loaded team increases its depth, and subsequent rains soak still further into the foundation, no evaporation can take place, and at length the entire road is almost impassable, and when the winter's frosts and the thawing weather of the spring comes on, the destruction is complete. The ballast, as applied, is a failure as a roof, and consequently the whole structure is a failure as a road. The radical defect in this piece of road was, that the ballast was too coarse. No stone should be put on a public road that will not go through an inch and a-half ring, because the main purpose of the ballast is to form a roof impervious to water, and small stones, ranging from an inch and a half down to powder, placed upon a prepared foundation, will compact into a mass almost as solid as concrete, and rain falling upon such a road is shed as effectually as from a cemented floor. A few minutes exposure afterward to the sun and wind will dry it off. and leave it in fine condition for immediate use. Here is the great secret of building roads, and in violation of this principle, no permanent and solid road can be constructed.

The practical question then arises, can such a road be built anywhere in Pennsylvania, and at moderate expense? The answer is, that wherever suitable stones are at all easily accessible, undoubtedly it can. A stone crusher can be had, mounted upon wheels, so as to be easily portable, and having an elevator from twelve to fifteen feet in length, for about six hundred to seven hundred and fifty dollars. Such a machine driven by an ordinary threshing engine of ten to fifteen horse power, is capable of crushing from forty to eighty cubic yards of stone in ten hours, with a force of six men, with one man to run the engine and oil the machinery, one man to feed the crusher, and four men to wheel the stones. Where the distance to haul does not exceed a mile each way, these stones can be prepared and put out upon the road ready for the public to travel, at a cost not exceeding sixty-five cents per cubic yard.

This assumes that the stones will not cost over about nine or ten cents per cubic yard at the pile before crushing. These figures are the result, not of calculation, but of repeated and carefully noted experiments, involving the crushing of hundreds of cubic yards of material and placing it upon the road. To do this, however, at this cost, it is necessary to have proper appliances for saving labor and facilitating work. A large platform ten feet by twelve, built of plank, should be constructed level with the mouth of the machine, and two run ways be made, upon one of which the stones are wheeled, and down the other the empty barrows are returned. At the mouth of the crusher a place should be arranged where the man who feeds it can stand, and not be required to stoop to any considerable degree, in order that he may move the stones off the platform into the mouth of the machine. The elevator should be long enough to allow a pile of from 80 to 100 cubic yards of stones to accumulate before it will be necessary to move the crusher.

The wagons for distributing the material on the road, should have their beds constructed so as to each hold a cubic yard; the sides to be made of one and one-half inch oak plank, and the rear end-gate to be hinged below like that on an ordinary spring wagon. When the bed is being filled, this end gate is secured above with hooks, which fit into staples that hold it in its place. The bottom is fitted with six inch boards, one and a half inches thick, which lie loose across the bed, and are supported at each end by ledges, which are fitted to the inside lower edge of the sides. When ready to unload, the driver drops the end gate by lifting the hooks which hold it in its place, and as it drops, the material runs out, leaving the first bottom board in view. With a pick this is lifted, and then another, and so on, until all the load is discharged, when the boards are replaced. This deposits the ballast just where it is needed in the road, and requires but little time and exertion to unload.

Before the material is placed upon the surface, the grading should be done, so as to raise the road bed high enough for proper drainage. This preliminary preparation should have been performed the previous year, and the public in the meantime have used the road, so as to thoroughly compact the earth. Before applying the stones, the surface should be again gone over with a road machine and put in smooth condition, all holes be filled, the earth compacted, and inequalities removed, so that the ballast may be spread evenly, and avoid the necessity of using this expensive material for filling up places that can, with care, be repaired with ordinary earth. In placing this ballast, put it in the centre of the road, and have the grades fall off each way, at a slope not exceeding one and a half to two inches to the yard, and upon all ordinary country roads, do not spread the stones wider than seven feet. This is wide enough for a single track, and will accommodate nine-tenths of the districts in the State very well. When all of the roads of the Commonwealth have been completed in this way, they may be widened, if experience shows it to be necessary

Near cities and large towns where traffic is nearly constant, a double track, is, of course, required. The amount of ballast for each rod of road seven feet wide, and its cost reckoned at the rate of sixty-five cents per cubic yard, is as follows:

Thickness.	Width.	Cubic feet.	Cost per rod.	Cost per Mile.
2 inches.	7 feet.	19.2	$0.46	$147 20
3 inches.	7 feet.	28.8	.69	220 80
4 inches.	7 feet.	38.4	.92	294 40
5 inches.	7 feet.	48.0	1.15	368 00
6 inches.	7 feet.	57.6	1.38	441 60

The roads, therefore, of Pennsylvania at this rate, can be piked six inches thick, with finely broken stones, in all districts where stones are easily obtainable, for $441.60 per mile, or in other words, the eighty thousand miles of road in this State can be piked in just nine years, with the annual tax no greater than that of 1895, and with no bonding of townships or increase of debt.

Until recently, engineers considered it necessary to excavate the earth and get a foundation below the surface, and then fill this in with stones to a depth of from ten to eighteen inches, in order to secure a proper foundation for a durable road, thus adding to the cost from two to four times more than the method here proposed. All of this is found to be unnecessary. The result of experiments made upon the highways of France go to show that roads built on top of a firmly compacted surface, will wear as well as those whose foundations have been laid deeper, and they have the advantage of costing far less to construct. It has also been found that a road ballasted from five to six inches thick, with finely broken stones, is able to carry all proper traffic that it may be called upon to bear.

Dr. Alfred Perkins Rockwell, in his recent report upon the roads of France, dated October, 1895, states: "In France the tendency has been to do away with the foundation, and to reduce the thickness of the upper layer, making it only so thick as to give sufficient resistance. In short, to build less costly roadways.

The system consists essentially in doing away with stone foundations of all kinds, and in replacing the two or three layers of the older system by a single layer of six to ten inches thick of small broken stone, which layer shall be impermeable to water. A stone roadway may be solid without being very thick. The essential condition is that it shall form a compact and impermeable mass, completely protecting the mass below from the effects of water. The twenty-two thousand miles of the "Routes Nationales" are periodically examined with great care, in order to ascertain the actual thickness of the stone layer. Tests were made in 1865, 1874, 1886 and 1891, at intervals of 656 feet. Along the road a trench is cut at right angles with the axis of the road from the middle to the outer edge of the stone layer. This trench is about twenty inches wide, and is dug with a pick down to the earth below. A perfect section is thus made of one-half of the road way. These trenches are cut alternately on the right and left sides of the axis of the road, so as to give sections the whole width, without, at the same time, interfering with travel. The general average of nearly 500,000 such tests made in 1895, showed a thickness of five and one-eighth inches. The average layer of broken stone, of roads with stone foundations, was four and one-half inches above the foundation; and on roads without foundation, five and seven-eighth inches. It ranges on roads without foundations from three and one-eighth to ten and five-eighths inches, and two-fifths of the "Routes Nationales" have a thickness of less than four inches; and one-eighth only, exceed eight inches."

Here is a demonstration, on a large scale, of the fact that deep foundations and thick layers of stone are unnecessary, and that the cost of well-constructed roads is not beyond the reach of most of the townships of Pennsylvania. A road, therefore, can be built in most of the districts of the State, be prepared for the ballast and a layer of broken stones deposited over it, six and one-half inches deep, and seven feet wide, for not over five hundred dollars per mile. Inside of ten years, therefore, with the present tax, the people of the State can have their roads well piked, in all districts where stones are abundant, which includes fully three-fourths of the roads of the Commonwealth. This, it is true, is not a perfect road, but it is a good road. It is DRY and it is SOLID, and with proper attention, will stand all reasonable wear. It is, moreover, within the reach of our citizens and would be the beginning of a more uniform and perfect system of road building in the State.

The third quality of a good road, is that it is of

Easy Grade.

Many roads are so located that no matter how dry or solid they may be, they are practically unserviceable, owing to the steep grades, which prevent rapid travel and the hauling of sufficient loads. The relocating of such roads is a serious difficulty in the solution of the road problem, and yet it is essential to a good road. In many places only slight changes of location would secure a comparatively level surface, but there is no one, under our present system, whose duty it is, or who has sufficient power, to effect a change. Consequently, grades are tolerated which every sensible citizen knows are unnecessary so far as the topography of the country is concerned, and are a great obstacle to comfortable travel and economical traffic. These steep grades are also difficult to maintain, requiring annually large expenditures to keep them in repair, and would also involve unknown sums of money to reduce. Future mistakes in this direction may be prevented, by the courts appointing, as viewers for the locating and laying out of new roads, men who realize the value of proper grades, and by firmly refusing to confirm their reports, unless they exhibit drawings of the elevations, showing that they have not exceeded the limit prescribed by law.

It should be made the sworn duty of all constables to report to the court all roads or sections of roads where the grade is greater than the law permits, upon which it should be the duty of the court to appoint proper viewers to inspect the grade, and report as to whether the road is improperly located, and whether the excessive grade is necessary and unavoidable by reason of the topography of the ground. If the grade is declared unnecessary, then a new location should be ordered, and a new road constructed with adjusted grade.

The fourth and last requisite in a good road, is that it shall be

Smooth.

Many roads are dry and reasonably solid, with easy grade, but are so rough as to be nearly impassable. Loose stones lie in the wagon tracks for months and are not removed. It should be the duty of the supervisor to see that, at least once each month, every loose stone in the road in his entire district is removed. Many a piece of rough road has been made quite passable by simply taking off the loose stones. If a given day each month is set apart for the picking off of the stones, it is more likely to be attended to, and much annoyance and public discomfort will be avoided, at a very small expense. Very soon it ought to be possible to offer a reward, for every stone as large as a man's fist that can be picked up in the middle of the road. It ought not to be possible to find one anywhere. All should be crushed so that none would be larger than would pass through an inch and a half ring.

These, then, are the qualities of a good road. DRY, SOLID, EASY GRADE, SMOOTH. Such roads are obtainable by nearly every district in the State, and to secure them no additional expenditure is needed, or any increase of tax, only a little more careful management in giving direction to the labor employed and money expended.

HOW TO MAINTAIN A GOOD ROAD.

The greatest enemy to a good road is neglect. No matter how carefully it may have been constructed, if it is permitted to take care of itself and lie neglected, it will be very soon destroyed. Drains become clogged, washes begin in the wagon tracks, freezing and thawing loosens the surface, overloaded wagons tear up the ballast and start channels for water, and every succeeding flood sweeps down the roadway, instead of through the sluices, often requiring the labor and taxes of an entire year to repair the loss, whereas, a little attention at the proper time would have preserved the whole intact and have kept it in good condition for public use. Lack of attention at the proper time is the great defect in our present system of public roads, entailing loss to the taxpayers of the State aggregating millions of dollars, and which if continued, will effectually prevent the possibility of good roads for all time to come.

Any road law that does not provide for the constant and intelligent care of our highways after they have been constructed, is defective in its most vital part, and will assuredly fail to meet the expectation of its friends, or the just demands of the people whose interests it is intended to promote. All public corporations, such as railroads, trolley and turnpike lines understand this, and they accordingly provide for frequent inspections and repairs. thus preventing waste, promoting durability, safety and economy, and adding each year to the efficiency and service of their road.

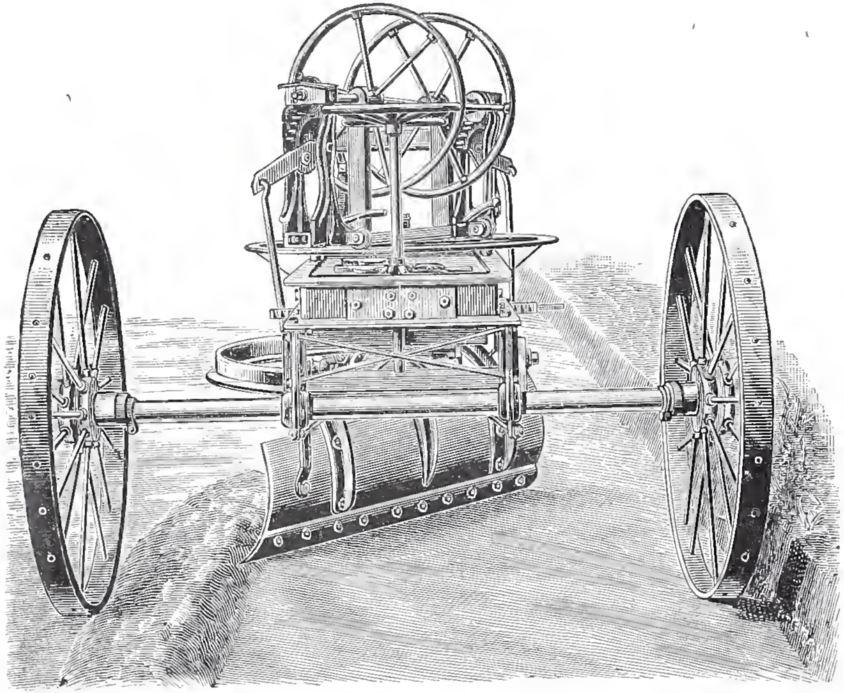
Every mile of road in Pennsylvania should have a competent person, who will be held responsible for its condition, and will see not only that it is not destroyed, but is daily improved. To secure this, the roads in the township should be divided into districts of not over twelve miles each, and a good common day laborer be put in each district, whose duty it will be to work every day on some portion of this road, and to be out especially on wet days, provided with water proof clothes, and a shovel, to turn the water off the track, opening drains, guarding bridges and noting the places that specially need repairing, so that when dry weather comes, these places can be put in order to resist the floods that otherwise would soon destroy them.

"Keep what you have," is a principle in all business, and then add to this year by year. This is true of roads. Keep what you have, and next year add to this, and so on year by year until a complete and substantial road has been constructed. The cost of this attention is comparatively slight, and its benefits are so apparent and valuable as to commend its practice by every road district in the State. One good man on the roads, in a wet day, is of more real service to the community, than all of the work of twenty-five of the best men in the township on a dry day. Roads do not run away in dry weather. They are swept off in wet weather, and it is then, of all times, that there is need of a watchman to guard against their loss. To this "section man" all labor can report, and since he is somewhere at work every day, the people, a few at a time, can come when it suits their convenience, and not be marshalled in great companies too cumbersome to properly control.

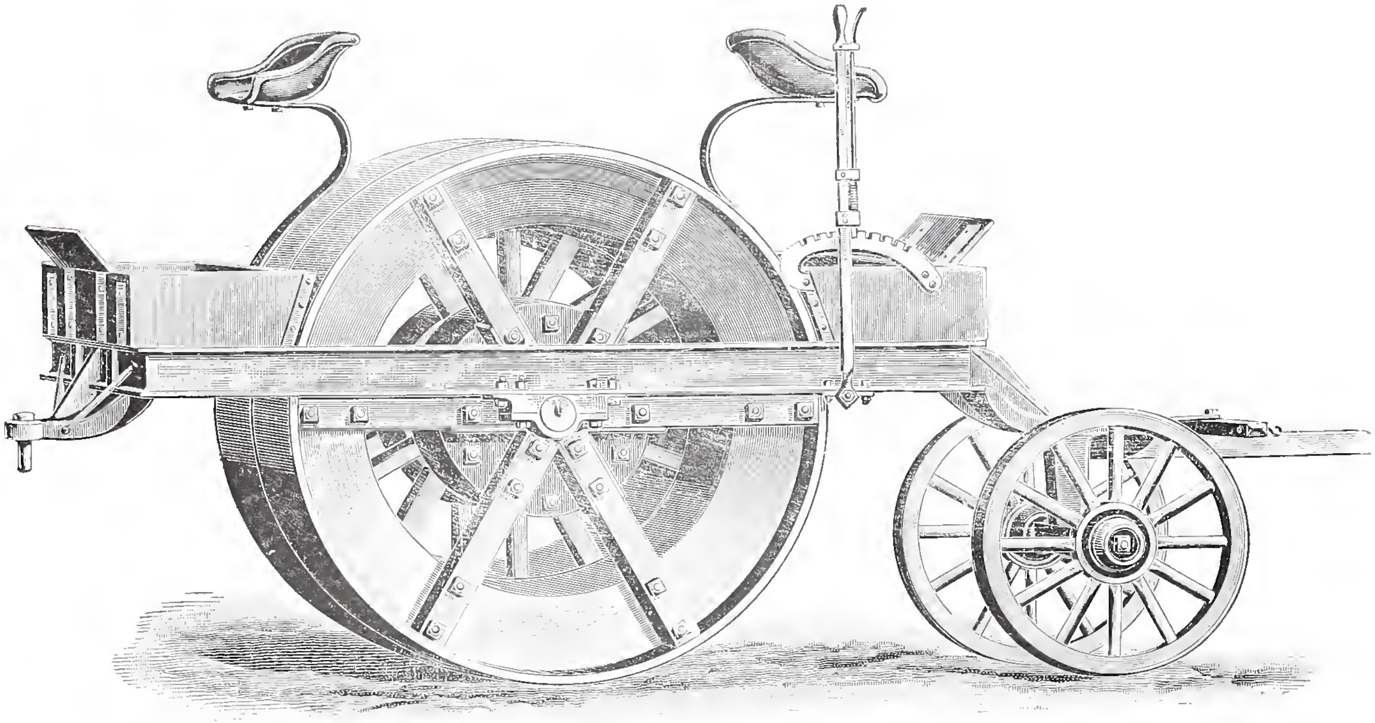
Additional Suggestions.

In many districts of the State the supervisors are elected for but a single year. Any policy in road constructing that may be adopted by such a board cannot be fairly tested in so short a period, and consequently those in charge hesitate to begin a work of permanent improvement for fear that they will not be continued in control sufficient time to demonstrate its value. There should be a degree of permanency in the office, and this could be secured if the supervisors were elected for three years, one going out each year, leaving two of the old officers as a majority in control, and give time to the newly elected official to become acquainted with the system and understand its purposes, before any radical change could be effected.

At least one-half of the road tax ought to be paid in cash. Bridges need repairing, and new ones need to be constructed, permanent stone culverts or terra cotta drains to carry water across the road ought to be provided instead of wooden structures that need constant repairs, road machinery ought to be purchased, the "section men" ought to be put in charge and be promptly paid. To do these things it is necessary that at least one-half of the tax should be paid in cash, and the other half can be paid in work. Every male taxable over twenty-one years of age, should be required to pay a road tax of at least, the price of one day's work.



APPENDIX.



How to Construct a Clay Road.

The implements needed are a road machine, roller and harrow. Prepare the bed with the road machine, giving it only a moderate slope so that the convexity will, when solid, be about one and one-half to two inches to the yard. Then roll it until it is thoroughly compacted. When ruts begin to form, run over it with a smoothing harrow twelve or thirteen feet wide, made in sections. Then roll thoroughly and repeat this operation whenever ruts begin to form. Keep side drains open and make frequent discharge ditches to carry water off of the right of way. Attention to these directions will keep a clay road in good condition for certainly ten months in the year.

Material for Ballast.

The selection of this is not usually a matter of choice, but is controlled by availability. The hardest and toughest stones are the best, and yet poor stone ballast is better than clay. When soft stones are plenty and hard ones scarce, use the soft for the under layer and dress the surface with the harder and more durable sort. Limestone. granite, flint, and trap rock are among the best. Sand stones, shales and slate are among the least durable, although there is great variability in the character of each of these. Creek gravel.

screened and well compacted with a roller, makes a smooth and durable road. The larger stones screened out should be run through the crusher before being used for ballast.

Implements for Road Building and Repairs.

The most economical method of road construction and repairs is by the use of machinery. The crusher, road machine, roller and harrow are indispensable in modern road building. It is largely through the use of these that the cost in construction has been reduced, and the expense of maintenance is brought to a minimum. By their use horse power is substituted for the too often incompetent workmen, and those in control are able to repair the highways at times when it would otherwise be impossible, owing to the farmers being occupied with their regular work.

The beginning, therefore, of good roads is in the purchase of suitable machinery, and no great advance in road construction can ever be secured until those in control of road affairs realize this fact and act accordingly.

Wide Tires.

All wagons hauling over two tons should be required to use six inch tires, the neglect of which should subject the owner to a considerable fine. A single load on a narrow tire often injures the road more than all of the other traffic of the year. It is manifestly unjust to require a community to construct its roads at twice or three times the ordinary cost, in order to provide against some individual, who could at slight expense for proper tires, avoid all injury, and do this with no inconvenience to himself. The possibility of constructing and maintaining good roads at reasonable cost, depends upon the enforcement of a wide tire law, and the sooner this is begun, the sooner the day of good roads will arrive.

Breakers.

Avoid constructing breakers whenever a culvert can be used. Use terra cotta or cast iron pipe, and put them in to stay. Properly put in, they will last for many years. On hills where the water is likely to flow down the ruts, breakers are sometimes needed. Construct them of finely broken stone, and not less than ten feet wide, with easy slope to both sides. This turns the water as effectually as if the breaker were abrupt, and prevents a sudden jolt to wagons as they pass, and avoids also the formation of mud holes, so common in front of these improperly constructed mounds.

Grades.

Before undertaking to construct a permanent road, be sure that it is of proper grade. If necessary, spend some money in correcting any that are too steep, and if it is found impossible to do this with reasonable cost, urge the tax payers to change the location to one better adapted to the public use. The law calls for not over five degrees, except where impracticable. If possible, bring it down to three.

Table of Grades.

1	Degree Grade,	92.16	feet per Mile, or a Rise of	1.74	feet per 100 feet.
2	do.	184.40	do. do.	3.49	do.
3	do.	276.70	do. do.	5.24	do.
4	do.	369.20	do. do.	6.99	do.
5	do.	461.90	do. do.	8.75	do.
6	do.	555.06	do. do.	10.51	do.
7	do.	645.12	do. do.	12.28	do.
8	do.	737.28	do. do.	14.05	do.
9	do.	829.44	do. do.	15.83	do.

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*Table of Traction.**

Showing the effect of grades upon draft, on roads of various methods of construction. All of the roads are supposed to be in first-class condition.

	Force required to draw a gross load of 2240 lbs. on a level.	Steepness of grade (rise per 100 ft.) on which the vehicle will not run back.	Draft on a Level Compared with that on Different Grades.					
			Rise in Feet per 100 Feet.					
			Level.	3 ft.	6 ft.	9 ft.	12 ft	15 ft.
	Pounds.	*Feet.*						
Earth road, . .	200	8.9	200	260	340	400	460	450
Gravel road, . .	143½	6.4	143½	215	273	344	416	474
Macadam road,	65	2.9	65	130	202	267	332	397
Telford road, .	46	2.0	46	115	179	248	313	377

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* Experiment Station, H. B., page 286.

Repairs.

Keep some finely broken ballast in various localities, easily accessible for use in repairing during the year. Slight repairs are constantly needed, and but little material is required, if the work is done before the break becomes too great. Put it on just after a rain and roll it down, so as to unite it with the bed below. Sometimes the surface should be slightly broken with a pick before applying the additional ballast. That "a stitch in time saves nine," is nowhere more applicable than in dealing with road repairs. Attend to them promptly and save expense.

Management in Winter.

Get ready for the winter by opening all the drains as late as possible in the fall. Keep the roads passable as long as practicable by the use of a snow plow, constructed of planks fitted together in triangular shape, so as to clear a space fully seven feet wide. Whenever roads drift full, arrange with the neighboring property owners to permit their fences to be opened and allow the public to travel through their fields, agreeing to pay for all damage that may be done by reason of this use.

A common road roller drawn back and forward through the snow as it falls compacts it, and prevents horses breaking through when the thawing begins in the spring. When the snow begins to disappear, cut drains through the side drifts at all suitable places, and provide for the discharge of water from the road way. Washing of the road bed, and consequently much expense for repairs is avoided, by timely attention to this advice. At points where drifts are most frequent, urge the property owners to construct wire fences instead of wood, and if necessary, aid them in making the change. This will often save much inconvenience and expense.

Mortgaging the Township.

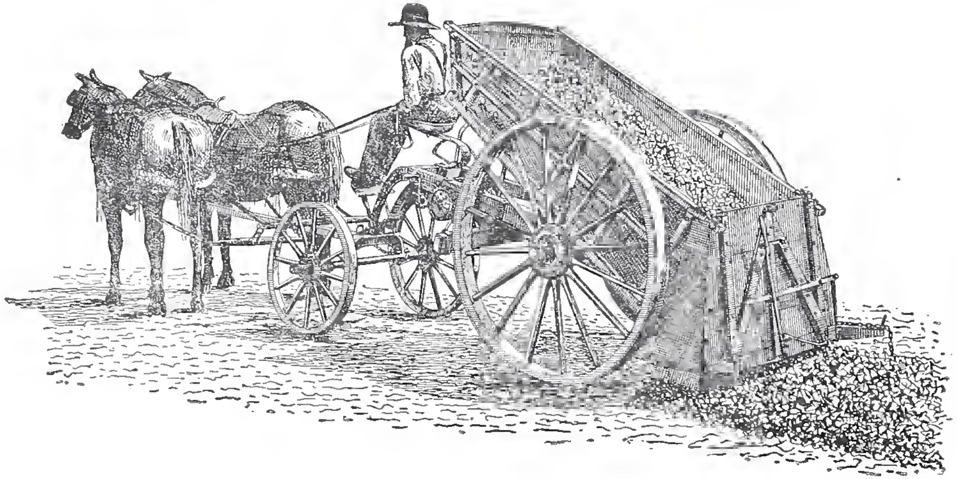
Do not be afraid to go in debt for road machinery; then stop and pay as you go. It will take more time to finish the work, but the roads will be paid for when they are completed.

Before State aid can be expected, the farmers of Pennsylvania must show that they are able to expend their own money in road construction to the best possible advantage. When they do this, State aid will come, and not before.

A Good Road is Dry and Solid, of Easy Grade and Smooth.

Print these words upon every finger board in Pennsylvania. Test each section by this, the only standard that will meet the requirements of twentieth century civilization. Let the farmers of Pennsylvania, with one accord, resolve that the wasteful methods heretofore permitted, shall no longer be pursued, and, at once, insist, that this business, over which they have control, shall be conducted in conformity with business rules. A "New Era" of ideas and institutions, of thought and progress is everywhere being ushered in. Old methods are fast becoming obsolete, and those who, Canute like, sit still, or actively resist the oncoming tide, will, most assuredly be overcome, and human progress will continue to sweep on until all who contend against its power are finally overthrown.

Let us resolve that the term "Country Roads," shall be no longer quoted against rural people as a synonym for incompetence and waste, but let us manage these roads in such a way, as to make them creditable to ourselves who are responsible for their control, and also, speedily put them in such condition, as shall make them of the highest service, to all of the citizens of this great Commonwealth in which we live.



COST OF CRUSHING AND DISTRIBUTING STONE.

Crushing.

Engine and engineer per day,	$3 00
Five men to feed the crusher,	5 00
Cost of coal per day,	75
Hauling water,	1 00
Rent of crusher per day,	3 00
Cost of crushing 70 cubic yards,	$12 75

Being 18 2-10 cents per cubic yard.

Distributing.

PLACING ON THE ROAD.

One two-horse team with driver, eight and two-thirds days, hauling eight loads per day of one cubic yard per load, at $2.50 per day,	$21 87
One hand, four and a half days, helping to load,	4 50
Cost of distributing 70 cubic yards,	$26 37

Being 37 7-10 cents per cubic yard for distributing, making the total cost 56 cents per cubic yard for crushing and distributing.

The hauling is done with two teams, and only one hand is needed to help to load, so that the entire 70 cubic yards are distributed in four and one-half days.

Cost of Constructing Earth Roads.

Rent of scraper one day,	$3 00
Six horses at seventy-five cents,	4 50
Two drivers,	2 00
One man on the machine,	1 25
Three hands to remove rocks, etc.,	3 00
Total cost per day,	$13 75

*Schedule of Road Tax Levied in the Several Counties of Pennsylvania, for the year ending May 31st, 1895.**

Adams,	$26,292	18
Allegheny,	193,820	52
Armstrong,	21,694	01
Beaver,	29,434	50
Bedford,	39,713	45
Berks,	113,240	64
Blair,	77,526	59
Bradford,	106,838	58
Bucks,	100,626	30
Butler,	68,631	85
Cambria,	43,964	43
Cameron,	7,109	25
Carbon,	23,258	28
Centre,	39,314	00
Chester,	140,312	25
Clarion,	41,132	77
Clearfield,	77,670	65
Clinton,	28,049	35
Columbia,	40,900	39
Crawford,	88,109	43
Cumberland,	45,997	67
Dauphin,	44,227	50
Delaware,	102,087	52
Elk,	35,880	00
Erie,	81,477	31
Fayette,	79,671	30
Forest,	23,163	52

Franklin,	$36,633 92
Fulton,	8,391 37
Greene,	38,635 12
Huntingdon,	26,280 83
Indiana,	50,365 31
Jefferson,	53,947 93
Juniata,	18,031 57
Lackawanna,	28,636 36
Lancaster,	123,652 30
Lawrence,	42,710 86
Lebanon,	44,183 88
Lehigh,	36,029 18
Luzerne,	89,235 18
Lycoming,	46,364 94
McKean,	51,064 16
Mercer,	48,617 99
Mifflin,	17,620 94
Monroe,	16,451 44
Montgomery,	183,639 91
Montour,	7,716 38
Northampton,	47,446 71
Northumberland,	43,193 59
Perry,	27,438 81
Philadelphia,	
Pike,	9,247 99
Potter,	51,155 65
Schuylkill,	110,601 59
Snyder,	18,042 75
Somerset,	48,901 38
Sullivan,	22,719 87
Susquehanna,	56,417 70
Tioga,	71,607 20
Union,	16,035 23
Venango,	45,393 00

Warren,	$50,997 04
Washington,	73,694 58
Wayne,	38,125 28
Westmoreland,	113,424 16
Wyoming,	14,062 40
York,	75,850 02
Total,	$3,622,708 76

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*This table is compiled, for the most part, from the report of the Secretary of Internal Affairs for 1895, and does not include the road tax paid by wards and boroughs and cities, but is simply the *township road tax* for that year.

Amount of Money Appropriated by the Several Counties for Roads and Bridges for the year ending May 31st, 1895.

(Report of the Secretary of Internal Affairs.)

Adams,	$5,181 48
Bedford,	11,583 05
Cambria,	12,400 51
Clearfield,	11,093 12
Columbia,	92,447 70
Cumberland,	2,319 58
Franklin,	1,182 56
Greene,	3,677 71
Juniata,	5,611 80
Lehigh,	19,454 26
Montgomery,	38,133 29
Montour,	1,526 46
Pike,	2,230 73
Tioga,	35,483 71
Union,	19,536 41
Washington,	6,778 36
Wayne,	7,224 47
Total,	$275,865 20

Summary.

Township taxes,	$3,622,708 76
County appropriations,	275,865 20
Total,	$3,898,573 96

HOW TO GET GOOD ROADS.

Get a Supervisor.

Do not search all over your township for the most incompetent man in it, and then elect him supervisor. Get your best men. Men who have business qualifications and who have succeeded in their own affairs, and who know what a good road is. Compel them to serve and support them in their efforts to carry their business training into the improvement of your roads.

Get Machinery.

No machinery no roads. Suitable machinery is absolutely necessary in order to have good roads. Go in debt for it. Do not delay purchasing. Do not pay an extravagant price for it. Make the companies guarantee against all breakage for one year. Do not keep it if it does not do satisfactory work. Good machines are made, and you can get them at reasonable prices.

Get Some Money.

It is impossible to construct good roads without some money. As has been elsewhere intimated, material must be paid for, machinery must be purchased, men must be paid who are steadily employed, and bridges need repairing and renewing. Culverts should be put in and sometimes damages must be paid for new locations for the road. Some money, therefore, is a necessity.

Get Material.

Get the best material available. Be particular to select that which will wear the longest. Bring it some distance, rather than take poor material, because it happens to be near. You are building a road that is to last, therefore get that which is durable.

Get to Work.

Do not play at road building. Go to work as though it was something worth doing well. Do not permit loafers to stay with your working force. Know what you want to do, and then do it. Do not slight any portion of the part you have undertaken to repair. Do it right.

Keep What You Have.

Do not let your roads drift away. Set a watchman over them, and hold him responsible. Require him to keep the work done this year, until the next, and then add to it; and so keep each year's addition, until a complete highway is constructed.

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